US008510376B2

(12) **United States Patent**
Kaczmarski et al.

(10) **Patent No.: US 8,510,376 B2**
(45) **Date of Patent: *Aug. 13, 2013**

(54) **PROCESSING REQUESTS TRANSMITTED USING A FIRST COMMUNICATION DIRECTED TO AN APPLICATION THAT USES A SECOND COMMUNICATION PROTOCOL**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 101 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/044,482**

(22) Filed: **Mar. 9, 2011**

(65) **Prior Publication Data**

US 2011/0161412 A1 Jun. 30, 2011

Related U.S. Application Data

(63) Continuation of application No. 11/076,609, filed on Mar. 10, 2005, now Pat. No. 7,945,676.

(51) **Int. Cl.**
G06F 15/16 (2006.01)

(52) **U.S. Cl.**
USPC **709/203**

(58) **Field of Classification Search**
USPC 709/202, 227, 228.25, 203; 713/153, 713/170
See application file for complete search history.

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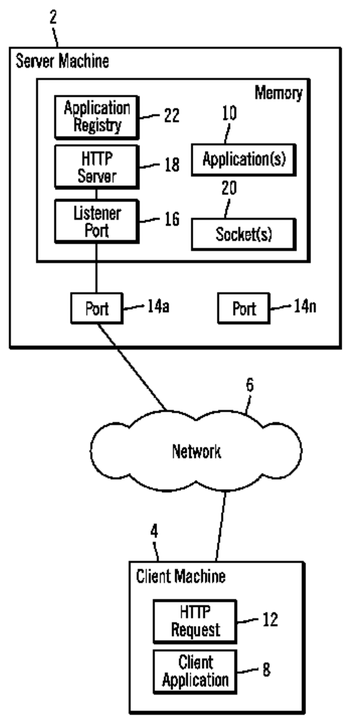
(57) **ABSTRACT**

Provided are a method, system, and program for processing requests transmitted using a first communication directed to an application that uses a second communication protocol. A request is received from one of a plurality of client computers over a network in a first communication protocol, wherein the client computers communicate over the network in the first communication protocol. A determination is made as to whether the request includes an identifier of an application indicated in a data structure. A socket is processed that enables communication between the application identified by the identifier in response to determining that the identifier included in the request is indicated in the data structure. The socket is provided to the application identified in the request to enable the application to communicate with the client over the network using a second communication protocol. The application transmits a response to the request using the second communication protocol and the provided socket, wherein the request from the client in the first communication protocol is sent to a first communication protocol server managing communication using the first communication protocol, wherein communication with the client following the response to the request is conducted using the second communication protocol and the socket and bypasses the first communication protocol server.

21 Claims, 5 Drawing Sheets



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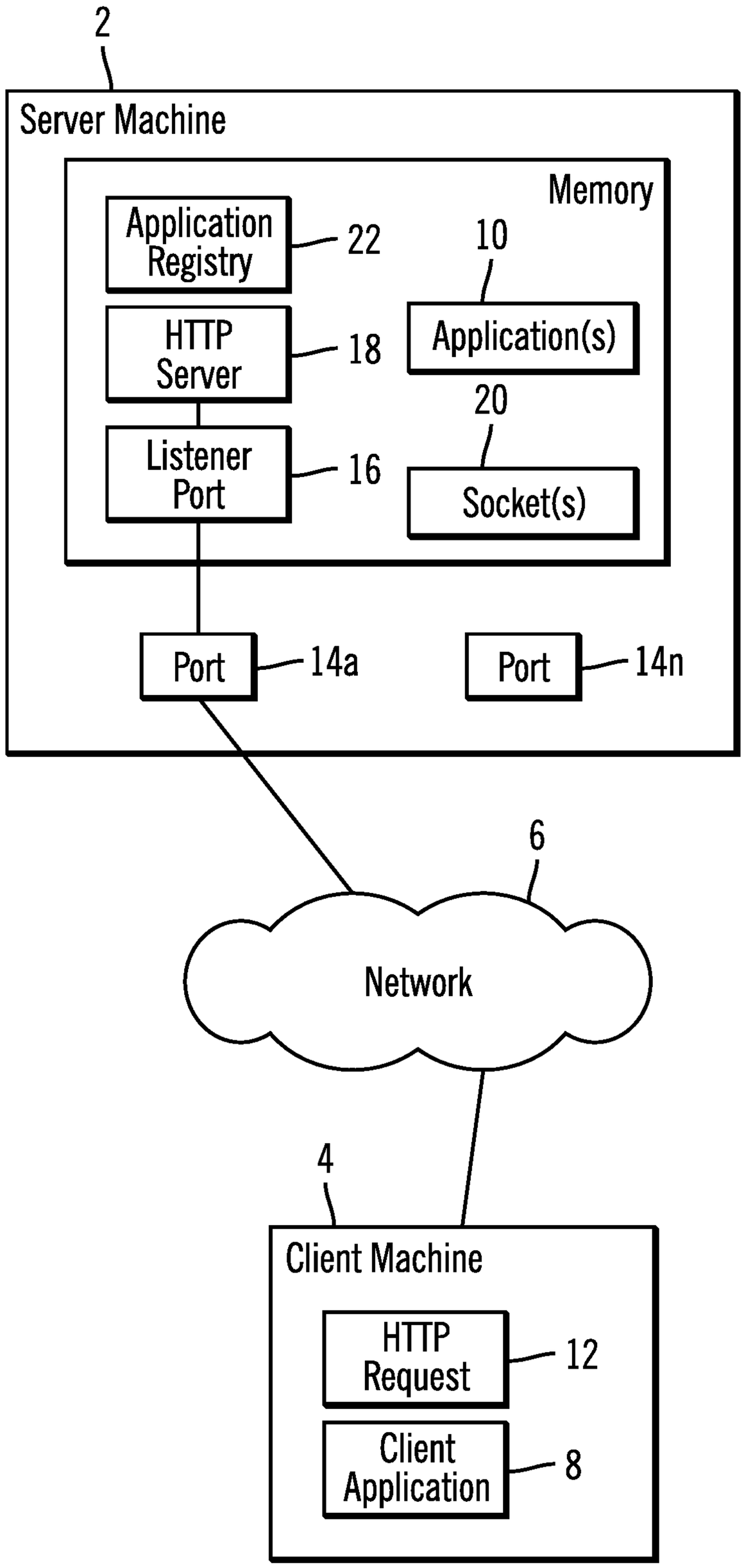
2
Server Machine
Memory
Application Registry
22
10
HTTP Server
18
Application(s)
20
Listener Port
16
Socket(s)
Port
14a
Port
14n
6
Network
4
Client Machine
HTTP Request
12
Client Application
8

FIG. 1

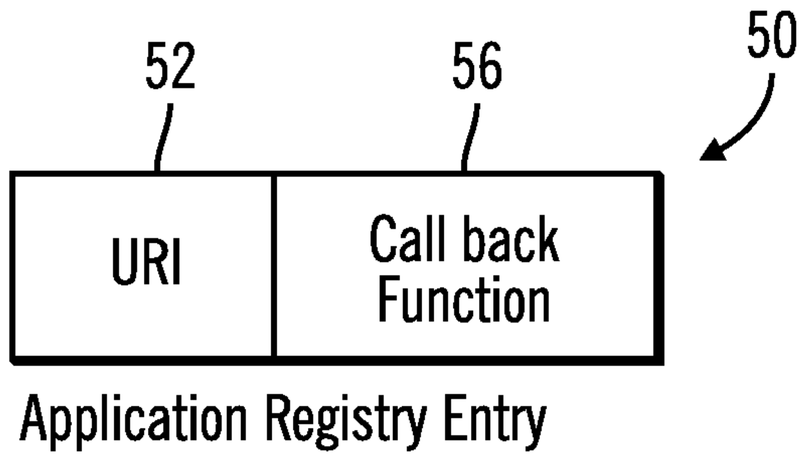

FIG. 2

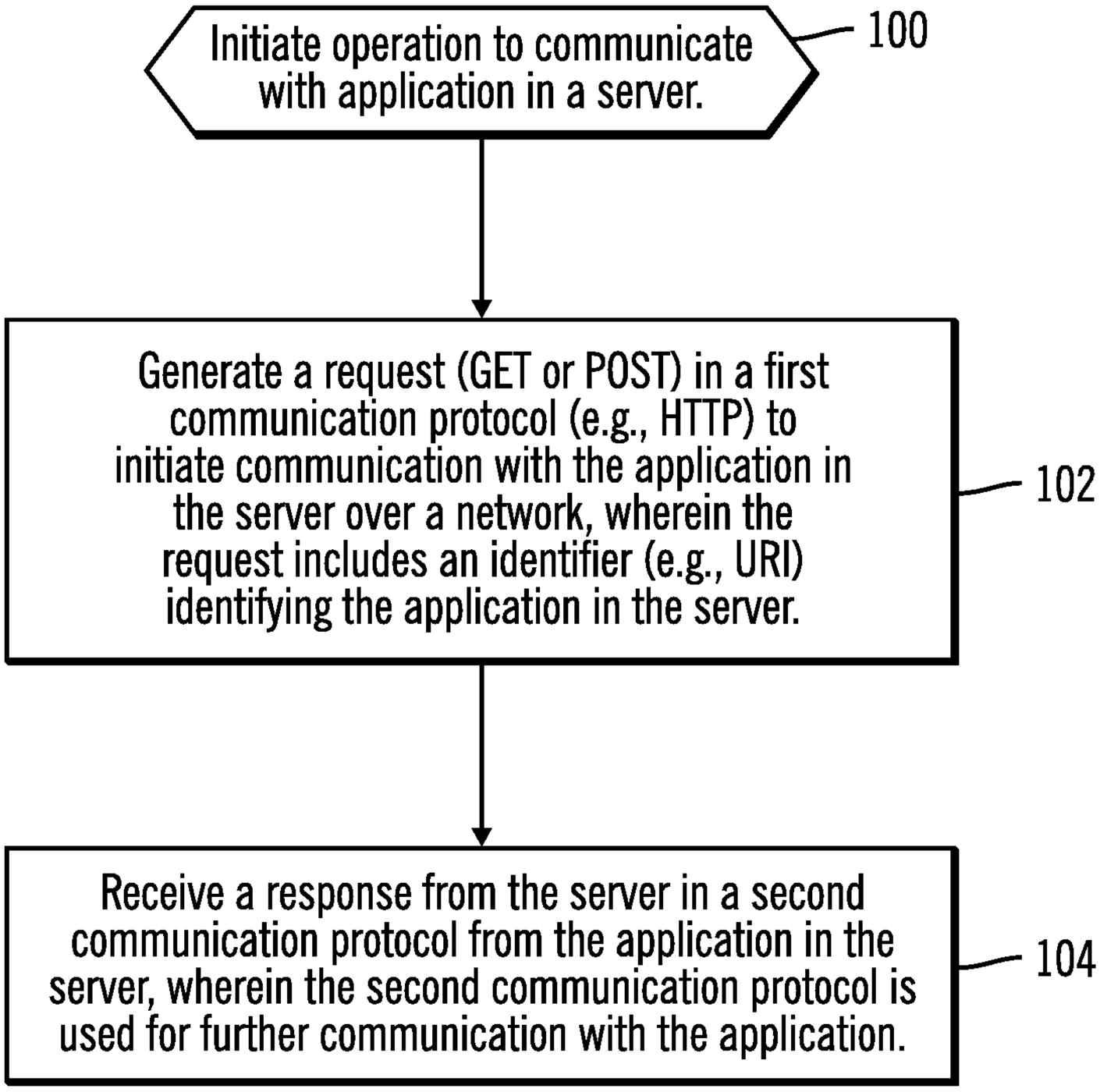
Initiate operation to communicate with application in a server.
100
Generate a request (GET or POST) in a first communication protocol (e.g., HTTP) to initiate communication with the application in the server over a network, wherein the request includes an identifier (e.g., URI) identifying the application in the server.
102
Receive a response from the server in a second communication protocol from the application in the server, wherein the second communication protocol is used for further communication with the application.
104

FIG. 3

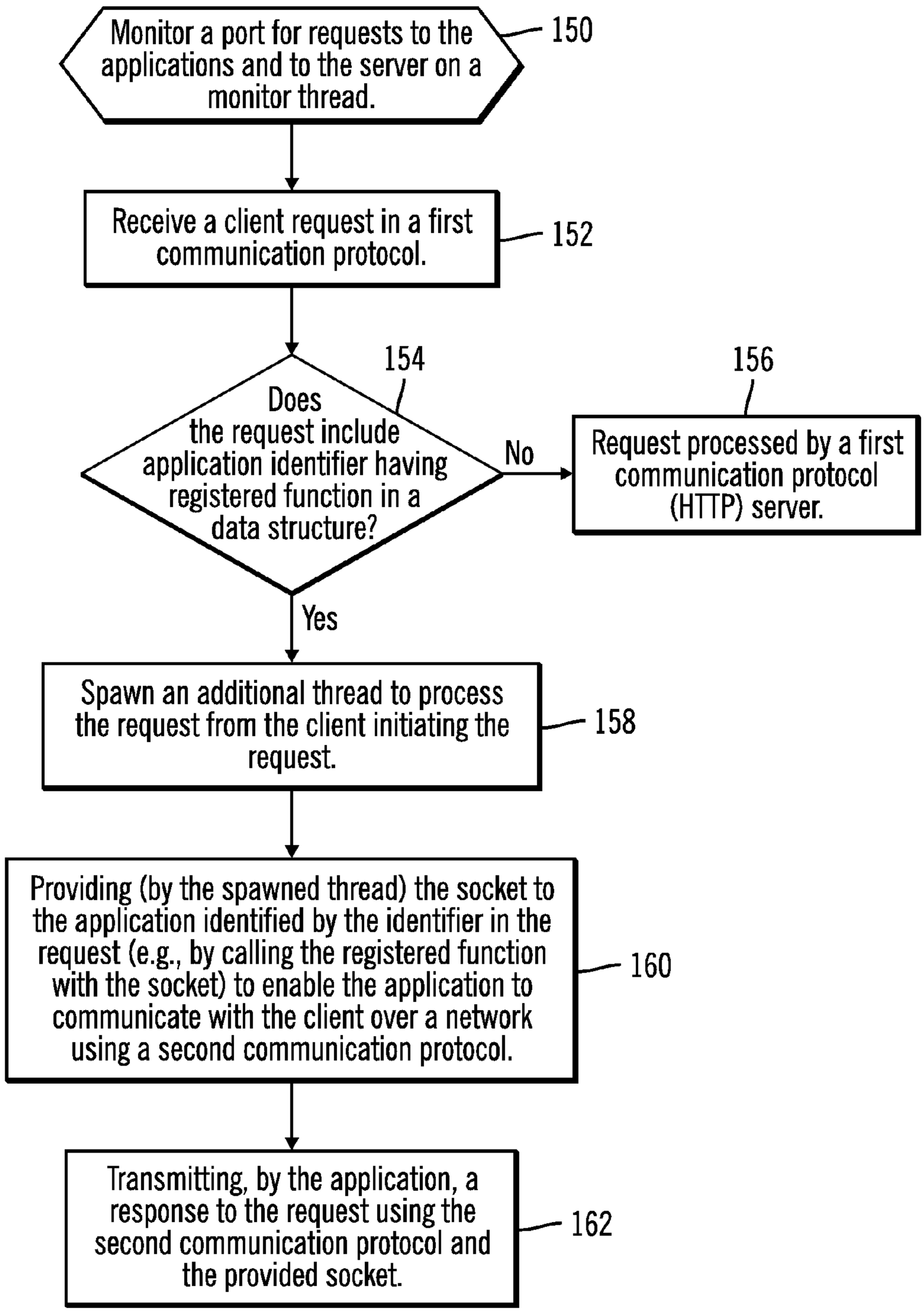
Monitor a port for requests to the applications and to the server on a monitor thread.
150
Receive a client request in a first communication protocol.
152
Does the request include application identifier having registered function in a data structure?
154
No
Request processed by a first communication protocol (HTTP) server.
156
Yes
Spawn an additional thread to process the request from the client initiating the request.
158
Providing (by the spawned thread) the socket to the application identified by the identifier in the request (e.g., by calling the registered function with the socket) to enable the application to communicate with the client over a network using a second communication protocol.
160
Transmitting, by the application, a response to the request using the second communication protocol and the provided socket.
162

FIG. 4

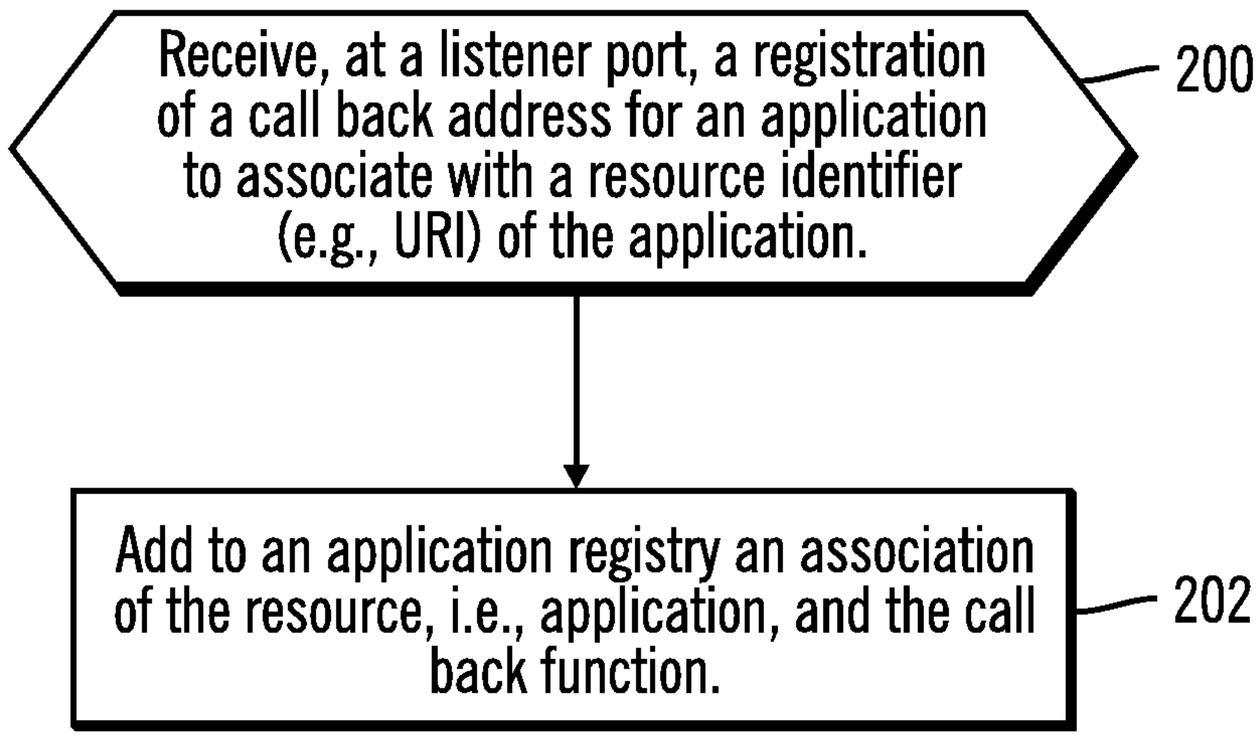
Receive, at a listener port, a registration of a call back address for an application to associate with a resource identifier (e.g., URI) of the application.
200
Add to an application registry an association of the resource, i.e., application, and the call back function.
202

FIG. 5

PROCESSING REQUESTS TRANSMITTED USING A FIRST COMMUNICATION DIRECTED TO AN APPLICATION THAT USES A SECOND COMMUNICATION PROTOCOL

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 11/076,609, filed on Mar. 10, 2005, which application is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method, system, and program for processing requests transmitted using a first communication directed to an application that uses a second communication protocol.

2. Description of the Related Art

A server machine may host a Hypertext Transport Protocol (HTTP) server application to process HTTP requests from HTTP clients on a port. The server machine may also provide access to non-HTTP applications and services on ports other than the port used for HTTP requests. The complexity of managing a firewall having multiple ports increases as the number of ports increases. Further, maintaining multiple ports open on a server machine subjects the server machine to additional points of access to hackers and other security threats.

SUMMARY

Provided are a method, system, and program for processing requests transmitted using a first communication directed to an application that uses a second communication protocol. A request is received from a client over a network in a first communication protocol. A determination is made as to whether the request includes an identifier of an application indicated in a data structure. A socket is processed that enables communication between the application identified by the identifier in response to determining that the identifier included in the request is indicated in the data structure. The socket is provided to the application associated with the requested resource to enable the application to communicate with the client over the network using a second communication protocol.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an embodiment of a network computing environment.

FIG. **2** illustrates an embodiment of an entry for a registered application.

FIGS. **3**, **4**, and **5** illustrate an embodiment of operations to process client requests in a server.

DETAILED DESCRIPTION

In the following description, reference is made to the accompanying drawings which form a part hereof and which illustrate several embodiments of the present invention. It is understood that other embodiments may be utilized and structural and operational changes may be made without departing from the scope of the present invention.

FIG. **1** illustrates a network computing environment including a server machine **2** and client machine **4** that communicate over a network **6**. There may be multiple client machines **4** that communicate over the network **6** with the server machine. The client machine **4** includes a client application **8** that intends to communicate with a server application **10**. The client-server application may comprise a database application, backup storage management program, or other client-server applications known in the art. To initiate communication with the server application, the client application **8** generates a Hypertext Transport Protocol (HTTP) request **12** and communicates this request using the HTTP protocol. However, following this initial HTTP request **12**, subsequent communication between the client application **8** and server application **10** involves the use of an application layer communication protocol known in the art other than HTTP, such as Simple Network Management Protocol (SNMP), Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP), Telnet, and any TCP/IP based interaction between the client application **8** and server application **10**. The server machine **2** and client machine **4** also use a transport layer protocol, network layer protocol, and data link layer protocol to communicate over the network. The application layer enables common communication of application services for the application **10**, **12** processes and provides semantic conversion between associated application processes.

The server machine **2** includes one or more ports **14***a*, **14***n*, where the ports **14***a*, **14***b* represent physical connections on one or more network adaptors (not shown), and a memory **14**. The memory **14** includes the application(s) **10**, a listener port **16**, an HTTP server **18**, communication sockets **20**, and an application registry **22**. The listener port **16** comprises a program that monitors one port, e.g., **14***a*, for inbound communications in the HTTP protocol directed to the HTTP server **18**. The HTTP server **18** handles HTTP requests and provides responses to requests. The communication sockets **20** comprise a programming construct used to send and receive information over a network connection, e.g., 6. When listening on a port, the application **10** accepts a connection by receiving a socket from the listener port **16** when an inbound connection is made. Similarly, when the client application **8** wants to create a connection to a remote program, e.g., application **10**, the client application **8** creates a socket, specifying the target address and port number and opens the socket to create the connection. After the client application or server application closes the connection the socket is gone and the next inbound connection on the port will return a new socket for the program to use for the connection. There may be one socket **20** for each server application **10** having an active communication link with one client application **8** in one client machine **4** over the network **6**. The socket **20** may maintain information such as the client machine **4** network address, e.g., an Internet Protocol (IP) address, the transport layer protocol, e.g., TCP, and a port **14***a*, **14***n* number. In this way, the server application **10** uses the socket **20** to direct communications to the client application **8**. The socket **20** enables communication between the server **10** and client **8** applications over the network **6** using an application layer protocol other than HTTP, i.e., the application layer protocol used for the initial communication.

The client machine **4** may comprise a computational device known in the art, such as a server, desktop computer, workstation, mainframe, hand held computing device, telephony device, etc. capable of communicating over the network **6** with the server machine **2**. The server machine **2** may comprise a suitable server system known in the art to manage backup messages from multiple systems. The network **6** may comprise one or more networks known in the art, such as a

Wide Area Network (WAN), Local Area Network (LAN), Storage Area Network (SAN), wireless network, the Internet, and Intranet, etc.

In one embodiment, the applications **10** may comprise legacy applications that utilize older legacy application layer protocols that are not handled by the HTTP server **18**.

FIG. **2** illustrates an entry **50** in the application registry **22** maintained for each application **10** communicating using an application layer protocol other than HTTP. The entry **50** includes a Uniform Resource Identifier (URI) **52** of the application **10**, i.e., the application **10** name and a call back function **12** that may be called with the socket **20** to handoff the request from the client application **8** to initiate communication with the server application **10**.

FIG. **3** illustrates operations performed by the client application **8** to initiate communication with the server application **10**. To initiate (at block **100**) operations to communicate with a server application **10**, the client application **8** generates (at block **102**) a request **12** (GET or POST) in a first communication protocol (e.g., HTTP) to initiate communication with the server application **10** over the network **6**. The HTTP request **12** includes an identifier (e.g., URI) identifying the target server application **10**. As discussed, although the client application **8** and server application **10** may communicate using an application layer protocol other than HTTP, such as a legacy application layer protocol, the initial communication request **12** comprises an HTTP request **12**. If the initial HTTP request **12** is processed successfully at the server machine **2**, then the client application **8** receives (at block **104**) a response from the server application **10** in a second communication protocol, i.e., an application layer protocol other than HTTP. This non-HTTP application layer protocol is used during subsequent communications between the client **8** and server **10** applications during the session initialized with the HTTP request **12**.

FIG. **4** illustrates an embodiment of operations performed in the server machine **2** to establish a connection between one server application **10** and the client application **8** which use a communication protocol, i.e., application layer protocol, other than HTTP (i.e., the application layer protocol used to establish the initial link). At block **150**, the listener port **16** monitors, on a monitor thread, one port, e.g., **14***a*, for requests to the applications **10** and the HTTP server **18**. Upon receiving (at block **152**) a client request, e.g., HTTP request **12**, in the first communication (application layer) protocol, the listener port **16** determines (at block **154**) whether there is a registered function **50** (FIG. **2**) for the application identified in the request in a data structure, i.e., the application registry **22**. If not, then the request is processed as a normal HTTP request by a first communication protocol, e.g., (HTTP), server. Such requests are not intended for one of the application **10**. If (at block **154**) the HTTP request **12** includes a registered application identifier in the application registry **22**, then an additional thread may be spawned (at block **158**) to process the request from the client application **8** initiating the HTTP request **12**. By spawning an additional thread, the main thread on which the listener port **16** executes can return to listening on the port **14***a*, **14***b* for an additional connection. In an alternative embodiment, threading may not be used, and then the server application **10** can only handle one connection at a time. The spawned thread further provides (at block **160**) the generated socket **20** to the server application **10** identified in the request. In one embodiment, the generated socket **20** may be provided to the application **10** to enable the application to respond to the request by calling the registered call-back function **52** with the socket to enable the application **10** identified in registry entry **50** (at field **54**) to communicate with the client machine **4** over the network **6** using a second communication (application layer protocol) different from the first communication protocol, e.g., HTTP.

This socket enables the client **8** and server **10** applications to communicate through the same port **14***a* used by HTTP requested directed to the HTTP server **18** even though the client **8** and server **10** applications do not use the HTTP protocol to communicate and intend to bypass the HTTP server **18**. By spawning a new thread, in one embodiment, the monitor thread executing the listener port **16** to monitor the port **14***a* is not burdened with having to perform the operations of generating the thread and calling the application **10** to handle communication with the requesting client application **8**. In response to being invoked by the call back function, the server application **10** may transmit (at block **162**) a response to the HTTP request using the second communication protocol, such as an application layer protocol other than HTTP. After this response, the client **8** and server **10** applications communicate through the sockets **20** established for application communication, which on the server side is socket **20**.

FIG. **5** illustrates operations performed by the listener port **16** to register an entry **50** (FIG. **2**) for the application **10** in the application registry **22**. Upon the listener port **16** receiving (at block **200**) a registration of a call back address and identifier (e.g., URI) for an application **10**, the listener port **16** adds (at block **202**) to the application registry **22** an application registry entry **50** having the identifier, e.g., URI, of the application **10** and the call back function that the listener port **16** may use to pass the socket **20** to the application **10** to use to communicate with the client application **8** initiating the request using any other TCP/IP based application layer protocol.

In one embodiment, the use of HTTP as the initial protocol allows Web services extensions to be applied to existing TCP/IP protocols because they are "tunneled" under the initial HTTP request. For example, the Web Services (WS) Security specification extension is used to authenticate the caller or WS-Policy to route the request to the appropriate web server application server based on quality of service or other criteria. Web Services extension requests, such as WS Security extensions may be transported using the HTTP protocol and the socket handling the communication with the application initiating the Web Services request is handed to the Web services application to enable the Web Services application on the server to communicate directly with the client initiating the Web Services request using a different communication protocol, such as Simple Object Access Protocol (SOAP) messaging.

Described embodiments provide techniques to enable a server having legacy applications and a protocol server, such as an HTTP server, handling requests for more current applications to use the same port for both the legacy (non-HTTP) and non-legacy (HTTP) application requests.

Additional Embodiment Details

The described operations may be implemented as a method, apparatus or article of manufacture using standard programming and/or engineering techniques to produce software, firmware, hardware, or any combination thereof. The term "article of manufacture" as used herein refers to code or logic implemented in hardware logic (e.g., an integrated circuit chip, Programmable Gate Array (PGA), Application Specific Integrated Circuit (ASIC), etc.) or a computer readable medium, such as magnetic storage medium (e.g., hard disk drives, floppy disks, tape, etc.), optical storage (CD-ROMs, optical disks, etc.), volatile and non-volatile memory devices

(e.g., EEPROMs, ROMs, PROMs, RAMs, DRAMs, SRAMs, firmware, programmable logic, etc.). Code in the computer readable medium is accessed and executed by a processor. The code in which preferred embodiments are implemented may further be accessible through a transmission media or from a file server over a network. In such cases, the article of manufacture in which the code is implemented may comprise a transmission media, such as a network transmission line, wireless transmission media, signals propagating through space, radio waves, infrared signals, etc. Thus, the "article of manufacture" may comprise the medium in which the code is embodied. Additionally, the "article of manufacture" may comprise a combination of hardware and software components in which the code is embodied, processed, and executed. Of course, those skilled in the art will recognize that many modifications may be made to this configuration without departing from the scope of the present invention, and that the article of manufacture may comprise any information bearing medium known in the art.

In the described embodiments, the first communication protocol comprised HTTP and the second communication protocol comprised an application layer protocol other than HTTP. In alternative embodiments the first communication protocol may comprise a communication protocol other than HTTP and the second communication protocol may comprise HTTP.

In the described embodiments, the first and second communication protocols comprised application layer protocols. In alternative embodiments, the first and second communication protocols may comprise an Open Systems Interconnection Reference Model (OSI Model) layer other than the application layer, such as one of the presentation layer, session layer, transport layer, network layer, data link layer, and physical layer.

The illustrated operations of FIGS. **3-5** show certain events occurring in a certain order. In alternative embodiments, certain operations may be performed in a different order, modified or removed. Moreover, steps may be added to the above described logic and still conform to the described embodiments. Further, operations described herein may occur sequentially or certain operations may be processed in parallel. Yet further, operations may be performed by a single processing unit or by distributed processing units.

The foregoing description of various embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention be limited not by this detailed description, but rather by the claims appended hereto. The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.

What is claimed is:

1. A method, comprising:

receiving a request from one of a plurality of client computers over a network in a first communication protocol, wherein the client computers communicate over the network in the first communication protocol;

determining whether the request includes an identifier of an application indicated in a data structure;

processing a socket that enables communication between the application identified by the identifier in response to determining that the identifier included in the request is indicated in the data structure;

providing the socket to the application identified in the request to enable the application to communicate with the client over the network using a second communication protocol; and

transmitting by the application a response to the request using the second communication protocol and the provided socket, wherein the request from the client in the first communication protocol is sent to a first communication protocol server managing communication using the first communication protocol, wherein communication with the client following the response to the request is conducted using the second communication protocol and the socket and bypasses the first communication protocol server.

2. The method of claim **1**, wherein multiple requests are received from multiple clients over the network including the identifier of the application, wherein the determining of the whether the request includes the identifier, processing the socket, providing the socket, and transmitting the application a response are performed with respect to multiple requests from multiple clients over the network to produce multiple responses to return to the clients.

3. The method of claim **2**, wherein communications with the clients following the responses to the requests are conducted using the second communication protocol and the socket to bypass the first communication protocol server.

4. The method of claim **1**, wherein there are multiple applications having communication with the clients over the network, and wherein a separate socket is provided for each application to use to communicate over the network using an application layer protocol other than the first communication protocol used by the clients to communicate with the applications using the sockets assigned to the application.

5. The method of claim **4**, wherein the applications use an application layer protocol other than the first communication protocol to communicate.

6. The method of claim **1**, further comprising:

passing the request from the client to the first communication protocol server in response to determining that the request does not include the identifier of one application indicated in the data structure.

7. The method of claim **6**, wherein the first communication protocol comprises the Hypertext Transport Protocol (HTTP) protocol, the first communication protocol server comprises an HTTP server, the identifier comprises a Uniform Resource Indicator (URI), and the second communication protocol comprises an application layer protocol other than HTTP.

8. A system in communication with a plurality of clients over a network, comprising:

a processor;

a memory in communication with the processor and including a data structure;

a first communication protocol server using a first communication protocol;

a computer readable storage medium including code executed by the processor to perform operations, the operations comprising:

receiving a request from one of the client computers over a network in the first communication protocol, wherein the client computers communicate over the network in the first communication protocol;

determining whether the request includes an identifier of an application indicated in a data structure;

processing a socket that enables communication between the application identified by the identifier in

response to determining that the identifier included in the request is indicated in the data structure;

providing the socket to the application identified in the request to enable the application to communicate with the client over the network using a second communication protocol; and

transmitting by the application a response to the request using the second communication protocol and the provided socket, wherein the request from the client in the first communication protocol is sent to the first communication protocol server managing communication using the first communication protocol, wherein communication with the client following the response to the request is conducted using the second communication protocol and the socket and bypasses the first communication protocol server.

9. The system of claim **8**, wherein multiple requests are received from multiple clients over the network including the identifier of the application, wherein the determining of the whether the request includes the identifier, processing the socket, providing the socket, and transmitting the application a response are performed with respect to multiple requests from multiple clients over the network to produce multiple responses to return to the clients.

10. The system of claim **9**, wherein communications with the clients following the responses to the requests are conducted using the second communication protocol and the socket to bypass the first communication protocol server.

11. The system of claim **8**, wherein there are multiple applications having communication with the clients over the network, and wherein a separate socket is provided for each application to use to communicate over the network using an application layer protocol other than the first communication protocol used by the clients to communicate with the applications using the sockets assigned to the application.

12. The system of claim **11**, wherein the applications use an application layer protocol other than the first communication protocol to communicate.

13. The system of claim **8**, wherein the operations further comprise:

passing the request from the client to the first communication protocol server in response to determining that the request does not include the identifier of one application indicated in the data structure.

14. The system of claim **13**, wherein the first communication protocol comprises the Hypertext Transport Protocol (HTTP) protocol, the first communication protocol server comprises an HTTP server, the identifier comprises a Uniform Resource Indicator (URI), and the second communication protocol comprises an application layer protocol other than HTTP.

15. A computer readable storage device including code executed to communicate with a plurality of clients over a network, access a data structure, and cause operations to be performed, the operations comprising:

receiving a request from one of a plurality of client computers over a network in a first communication protocol, wherein the client computers communicate over the network in the first communication protocol;

determining whether the request includes an identifier of an application indicated in a data structure;

processing a socket that enables communication between the application identified by the identifier in response to determining that the identifier included in the request is indicated in the data structure;

providing the socket to the application identified in the request to enable the application to communicate with the client over the network using a second communication protocol; and

transmitting by the application a response to the request using the second communication protocol and the provided socket, wherein the request from the client in the first communication protocol is sent to a first communication protocol server managing communication using the first communication protocol, wherein communication with the client following the response to the request is conducted using the second communication protocol and the socket and bypasses the first communication protocol server.

16. The computer readable storage device of claim **15**, wherein multiple requests are received from multiple clients over the network including the identifier of the application, wherein the determining of the whether the request includes the identifier, processing the socket, providing the socket, and transmitting the application a response are performed with respect to multiple requests from multiple clients over the network to produce multiple responses to return to the clients.

17. The computer readable storage device of claim **16**, wherein communications with the clients following the responses to the requests are conducted using the second communication protocol and the socket to bypass the first communication protocol server.

18. The computer readable storage device of claim **15**, wherein there are multiple applications having communication with the clients over the network, and wherein a separate socket is provided for each application to use to communicate over the network using an application layer protocol other than the first communication protocol used by the clients to communicate with the applications using the sockets assigned to the application.

19. The computer readable storage device of claim **18**, wherein the applications use an application layer protocol other than the first communication protocol to communicate.

20. The computer readable storage device of claim **15**, wherein the operations further comprise:

passing the request from the client to the first communication protocol server in response to determining that the request does not include the identifier of one application indicated in the data structure.

21. The computer readable storage device of claim **20**, wherein the first communication protocol comprises the Hypertext Transport Protocol (HTTP) protocol, the first communication protocol server comprises an HTTP server, the identifier comprises a Uniform Resource Indicator (URI), and the second communication protocol comprises an application layer protocol other than HTTP.

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